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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/313,764	05/18/1999	AKITO KURAMATA	990527	4289

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EXAMINER

COLEMAN, WILLIAM D

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 11/30/2001

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/313,764

Applicant(s)

KURAMATA ET AL.

Examiner

W. David Coleman

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 27 August 2001.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) 5 and 14-17 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 6-13 and 18-20 is/are allowed.
- 6) ☒ Claim(s) 1-4 and 21-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☒ The proposed drawing correction filed on 27 August 2001 is: a) ☒ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed August 27, 2001 have been fully considered but they are not persuasive.
2. Pertaining to claims 1-3 and 21, Applicant contends that the 35 U.S.C. 103(a) as being unpatentable over Edmond et al., U.S. Patent 6,120,600 in view of Nakamura et al., U.S. Patent 5,747,832 rejection should be withdrawn because the object of the present invention is to decrease the resistance between the substrate and the buffer layer. Applicant contends that Edmond et al. comprises buffer 42 containing AlN, not AlGaN and not AlGaN directly on the substrate.
3. In response to Applicant's contention that Edmond fails to disclose a buffer layer containing AlGaN, see FIG. 2 of Edmond et al. where 42 comprises both AlN and AlGaN as the buffer layer. Furthermore, omission of an element and its function is obvious if the function of the element is not desired (i.e., AlN being an insulating layer having a high resistance which is not desired in the present Application). Also Edmond teaches an embodiment wherein the buffer layer comprises a graded composition of silicon carbide, aluminum gallium nitride (column 5, lines 63-67 and column 6 lines 1-6). *Ex parte Wu*, 10 USPQ 2031 (Bd. Pat. Ap. & Inter. 1989). See also *In re Larson*, 340 F.2d 965, 144 USPQ 347 (CCPA 1965).

Claim Rejections - 35 USC § 103

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4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1, 2, 3, and 21-~~24~~²³ are rejected under 35 U.S.C. 103(a) as being unpatentable over Edmond et al., U.S. Patent 6,120,600 in view of Nakamura et al., U.S. Patent 5,747,832.

6. Pertaining to claims 1, 2, 21, 22 and 23, Edmond (600) discloses a semiconductor device substantially as claimed. See **FIGS. 1**, where a silicon carbide (SiC) substrate **21** has a first conductivity (n-type) and a buffer layer formed on the substrate **21** with a composition represented by the compositional parameter x as $Al_xGa_{1-x}N$. Also Edmond teaches an embodiment wherein the buffer layer comprises a graded composition of silicon carbide aluminum gallium nitride (column 5, lines 63-67 and column 6 lines 1-6). A first cladding layer **23** comprises a first conductivity type (n-type) formed epitaxially, an active layer **25** formed epitaxially formed on the first cladding layer. A second cladding layer **30** having a second opposite conductivity type (p-type). The second cladding layer is of an epitaxial nature (see columns 7-8, where Edmond discloses epitaxial growth temperatures and process). A first electrode **31** is provided to inject first-type carriers having a first polarity into the second cladding layer **30** and a second electrode **32** provided on the substrate so as to inject second type (p-type) carriers having a second polarity. The buffer layer having a compositional parameter x larger than 0 but smaller than 0.4 ($0 < x < 0.4$) as seen in **FIG. 6**. Please note that **FIG. 1** does not include

an insulating layer. However, Edmond fails to disclose the carrier concentration in the range as claimed. Nakamura discloses an $\text{Al}_x\text{Ga}_{1-x}\text{N}$ layer comprising a carrier concentration of $1 \times 10^{20}/\text{cm}^3$ (column 14, line 3) also pertaining to claim 21, the p-type layer is doped with Mg (column 6, line 63). In view of Nakamura, it would have been obvious to one of ordinary skill in the art to teach the claimed carrier concentration because the claimed range provides a low-resistivity layer (column 13, line 23).

7. Pertaining to claims 3 and 21, Edmond (600) discloses a semiconductor device having a compositional parameter x of a buffer of less than 0.09 (where $x < 0.09$). See FIG. 6, where the compositional parameters are shown.
8. Claims 4 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edmond et al., U.S. Patent 6,120,600 in view of Nakamura et al., U.S. Patent 5,747,832 as applied to claims 1-3 above, and further in view of Powell et al., U.S. Patent 6,165,874.
9. Edmond (600) in view of Nakamura discloses a semiconductor device substantially as claimed as discussed above. However, the combined teachings fail to teach the crystal orientation of the silicon carbide substrate. Powell discloses a semiconductor device wherein the crystal orientation is taught as Applicant's claimed orientation. See column 7, lines 15-28, where silicon carbide polytypes are formed by the stacking of double layers of Si and C atoms. Each double layer may be situated in one of three positions, known as ABCACBABCACB... for 6H. The stacking direction is designated as the crystal c-axis and is in the crystal [0001] direction; it is perpendicular to the basal plane which is the crystal (0001) plane. In view of Powell, it would have been obvious to one

of ordinary skill in the art to claim a silicon carbide substrate having a crystal orientation of (0001) in the combined teachings of Edmond (600) and Nakamura because the GaN based Group III and Group V nitrides semiconductors have bonded polytypes similar to those of SiC (column 7, lines 46-50).

Allowable Subject Matter

10. Claims 6-13 and 18-20 allowed.
11. The following is an examiner's statement of reasons for allowance: prior art does not teach a semiconductor device wherein a substrate of SiC having a first conductivity type; a first cladding layer having a first conductivity type, the first cladding layer being formed on the substrate epitaxially; an active layer formed epitaxially on the first cladding layer; a second cladding layer having a second, opposite conductivity type, the second cladding layer being formed on the active layer epitaxially; a third cladding layer having a second conductivity type, the third cladding layer being formed on the second cladding layer epitaxially; a contact layer of a second conductivity type, the contact layer being formed on the third cladding layer; a first electrode provided on the contact layer; a second electrode provided on the substrate; the third cladding layer forming a ridge structure having a T-shaped cross-section, the third cladding layer including, at a bottom part thereof, a pair of cuts, such that the cuts penetrate from respective lateral sides of the ridge structure toward a center of the ridge structure..
12. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably

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accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

13. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

14. A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to W. David Coleman whose telephone number is 703-305-0004. The examiner can normally be reached on 9:00 AM-5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M. Fahmy can be reached on 703-308-4918. The fax phone numbers for the

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organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7721 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

W. David Coleman
Examiner
Art Unit 2823

WDC
November 8, 2001

A. Pham
LONG PHAM
PRIMARY EXAMINER